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<http://dx.doi.org/10.1108/APJML-02-2015-0018>

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# **Outsourcing Maintenance in Complex Process Industries: Managing Firm Capabilities in Lock-in Effect**

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N.B.: When citing this work, cite the original article.

This is a so-called personal version (author's manuscript as accepted for publishing after the review process but prior to final layout and copy editing) of the article.

Original Publication:

Jane Frances Maley, Christian Kowalkowski, Staffan Brege, Sergio Biggemann, (2015) "Outsourcing maintenance in complex process industries: managing firm capabilities in lock-in effect", Asia Pacific Journal of Marketing and Logistics, Vol. 27, No 5. <http://dx.doi.org/10.1108/APJML-02-2015-0018>

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# **Outsourcing Maintenance in Complex Process Industries: Managing Firm Capabilities in Lock-in Effect**

## **Purpose**

The aim of the article is to analyze the rationale for choice of suppliers and the influence these decisions have on the firm's capabilities.

## **Design/methodology/approach**

We examine the choice of in-house operations versus buying maintenance in the Swedish mining industry through a qualitative case study approach.

## **Findings**

The findings reveal a strong tendency to outsource maintenance.

## **Research limitations/implications**

This in turn has a strong influence on the firm's capabilities and long-term competitive advantage and sustainability.

## **Practical implications**

Based on the empirical findings, we comment on the strength and weaknesses of the different outsourcing and attempt to find practical solutions that assist the firm in creating competitive advantage.

## **Originality/value**

The unique contribution of this study is that it extends prior firm capabilities studies by investigating the impact of capability loss specifically in complex, intricate maintenance processes in a dynamic industry.

## Introduction

General and service outsourcing and *the 'make or buy' question* have been at the centre of interest for management scholars and practitioners for decades (i.e. Barthélemy, 2001; Barthélemy and Quélin, 2006; Bettis, Bradley and Hamel, 1992). One of the major paradoxes has been the question of when does outsourcing *'hurt or benefit'* firm performance? On the one hand, the compelling advantages of outsourcing include increased efficiency (Sivakumar, Kannan, and Murugesan, 2014) and ultimately increase in profit (Fill and Visser, 2000; Holcomb and Hitt, 2007; Kremic, Tukel and Rom, 2006; Marquez, 2007; Moeen, Somaya and Mahoney, 2013). On the other hand, outsourcing engagements is well documented as causing 'lock-in effect' (Lei and Hitt, 1995).

However, more recently, outsourcing research has changed focus. More attention has been given to outsourcing service activities that have moved beyond basic value chain activities to encompass more elaborate areas such as service maintenance (Barthélemy, 2006; Quinn, 2000; Useem and Harder, 2000). A working example is contemporary process industries. Service maintenance in these industries is not only predictably outsourced; it has also become very complex (Lewis and Steinberg, 2001). For example, process plants are now automated, sophisticated and integrated. As a result, outsourcing has become more intricate and the knowledge required to manage the outsourced activity and the supplier has become progressively more challenging (Márquez, 2007).

The purpose of this paper is not to attempt to respond to the question of when does outsourcing *'hurt or benefit'* the firm? We accept that outsourcing has become a permanent and irreversible feature of the process industry (Aubert, Patry and Rivard, 1998; Aubert, Patry and Rivard, 2003; Bahli and Rivard, 2003; Kern and Willcocks, 2002; Williamson, 1985; Powell and Brantley, 1992), and the outsourcing of service maintenance is no exception (Kumar and Kumar, 2004). Instead, we turn this question on its head and explore how the firms handle the permanency of outsourcing. In particular, how they cope with the pervasive reality of lock-in effect as a result of outsourcing processes that are both complex and critical to the firm.

Lock-in effect is explored through a qualitative case study in the context of the Swedish mining sector. Our sample includes two well-established firms and two smaller immature firms, almost the entire Swedish mining sector. Namely we: 1) *verify the firm's genuine rationale for outsourcing maintenance*, and 2) *explore the impact of lock-in effect on the outsourcing firm*. We focus our attention on one of the apparent outcomes of lock-in effect, the loss of firm capabilities to the outsourcing supplier (Bettis, Bradley and Hamel, 1992; Imam, Iftikhar, Bajwa and Aslam, 2012).

The study makes several contributions to scholarship. Firstly, it extends prior outsourcing literature by exploring the neglected issue of decision-making determinants in outsourcing (Fill and Visser, 2000). Secondly, the study responds to pressing calls for more work in the procurement of firm capabilities (Weigelt, 2009). Thirdly, it examines the topic of managing lock-in effect. The academic literature has generally been silent on 'managing' within a lock-in effect setting and the integration between lock-in and firm capabilities. This is a significant gap, as organizations have little theoretical or empirical guidance on how to maximize the integration of lock-in and capability management and how to maximize the contribution of lock-in to organizational performance.

Thus by exploring the questions of lock-in, we hope to make a significant contribution to both scholarship and management practice. This paper aims to begin a dialog around the acceptance of lock-in effect and the management of firm capabilities in a complex processes environment. It draws upon resource based theories to integrate these areas of practice and provide a theoretical foundation in this important area. A central argument in the paper is that lock-in as a reality needs to move from an overly transactional focus on compliance and negotiation issues, to a more strategic focus that ensures the organization can effectively deliver its strategy.

The paper is structured in three parts. In the first section, the theoretical framework commences with a synopsis of the importance of mining and maintenance. It also includes a brief discussion of the concept of outsourcing and lock-in effect. There is also an overview of the theoretical lens of the resource-based views (RBV) incorporating dynamic capabilities, absorptive capacity and alliance

capabilities. The second section includes the methodology and the analysis of the results. The third section incorporates the discussion and includes practical suggestions for firms to strategically and effectively incorporate outsourcing and the conclusion incorporates implications for future research.

## **Theoretical framework**

### *Mining*

Mining is a good example of a processing industry where maintenance is routinely outsourced. Evidence of outsourcing maintenance in the mining sector is demonstrated in: Sweden (Kumar, 2004); US (Peterson, 2001); Brazil (Lewis and Steinberg, 2001); China (Chen, 2010); South Africa (Kenny and Bezuidenhout, 1999) and Australia (Bowden, 2003). Mining is an appropriate industry in which to explore the maintenance outsourcing phenomenon. The industry is of great significance to the global economy, yet is in the midst of uncertain times. For example, decreasing commodity prices, demand, head grade, capital availability, and increasing environmental requirements have brought into question the long-term viability of the mining industry in many countries (Deloitte, 2015; Rolfe, Miles, Lockie and Ivanova, 2007; Sivakumar et al., 2014). For many mining companies maintenance spending accounts for a significant part of their operating budgets but ‘service and maintenance areas’ are ironically often considered a minor element in strategic operations planning (Kumar and Kumar, 2004). Moreover, the long-term impact on the outsourcing firm of continued outsourcing of maintenance is largely unknown, in particular, on the impact on the firm’s vital skills (capabilities).

Mining operations are extremely complex, typically involving hundreds of pieces of heavy equipment, including trucks to move and dispatch ore, drilling machines, processing equipment and dumping machines. Each piece of equipment has its own maintenance service complexities and is made up of hundreds of components—from motors to gearboxes and sump pumps—any of which, if damaged or left unmaintained, could cause a huge, costly problem for a high stakes operation (Earls, 2013). Yet, timely maintenance can make the difference between minor downtime and hundreds of

thousands of dollars in lost production and costly equipment replacement, significantly improving business efficiency (Earls, 2013). Unlike operational activities, maintenance activities are mostly non-repetitive in nature (Lewis and Steinberg, 2001). Therefore, maintenance personnel face different problems with each breakdown or downtime of the plant or system, which needs multi-skill levels to solve the conflicting multi-objective issues (Parida and Kumar, 2009).

### *Maintenance*

Maintenance is a pertinent context in which to study outsourcing because not only has maintenance outsourcing become so widespread, it has also become a more strategic issue for the firm (Stremersch, Wuyts and Frambach, 2001). When maintenance fails there follows a negative domino effect that flows through costs, productivity, lead-times and quality. Additionally, there is a strong lock-in effect of suppliers of different kinds of investment goods. These lock-in effects seem to be stronger over time as a consequence of the more technically complex nature of maintenance, and the fact that maintenance contracts tend to be integrated with after sales service and maintenance solutions (Biggemann, et al., 2013).

### *Lock-in effect*

Whilst, the literature is visibly divided on outsourcing, what is clear is that as outsourcing has proliferated in industry (Powell and Brantley, 1992); it has induced a lock in effect (Aubert, et al., 1998; Aubert, et al., 2003; Bahli and Rivard, 2003; Kern and Willcocks, 2002; Williamson, 1985). The term lock-in refers to a situation where a client cannot get out of a relationship except by incurring a loss or sacrificing part or all of its assets to the supplier (Aubert, *et al.*, 1998).

The major concern of outsourcing is that one party could breach the contract resulting in a reduction in the value of the relationship-specific outlay. This results in the lock-in effect, where much can be lost to both the firm and the supplier if the relationship dissolves (Williamson, 1985; Kern *et al.*, 2002b). Having invested a great deal of effort in getting the supplier functioning, the firm may be disinclined to start over with a new supplier. If the firm has not retained in-house capabilities

with the outsourced maintenance activity, they may even be unable to do so (Aubert, *et al.*, 2003). In other words, the supplier may develop critical expertise and competencies at the expense of the outsourcing firm. Whilst it has been recognized that firms need to consider their capability attributes and their strengths and weaknesses prior to outsourcing (Mahhok, 2002), exactly how they should consider them is less well documented and understood.

Salancik and Pfeffer (1978) argue that, as firms inevitably rely on outsourcing partners, this situation creates dependency on the suppliers resulting in a dual effect of uncertainty and conflict.

The risks associated with lock-in can be intensified if there is a restricted number of suppliers, since the bargaining power of suppliers increases as their number decreases (Porter, 1985; Williamson, 1985). Additionally, if the outsourcing firm lacks expertise with outsourcing contracts, it may intensify the lock-in effect (Aubert *et al.*, 1998). A firm with little expertise may make decisions that will directly lead to a lock-in situation. Bahli and Rivard (2003) assert that a firm without supplier experience predictably and naively sign contracts without adequate clauses for: termination of the contract; asset buy-back; handover obligations and intellectual property rights. This leads to a situation that typically renders the termination of the supplier almost impossible.

Due to the mounting ‘technical intricacy’ of contemporary maintenance and the resultant high dependency on the supplier, the negative consequences of outsourcing may be intensified in the processing industry. By ‘technical intricacy’ we refer to the dramatic change in the use of technology in processing plants, growing reliance on computer software and the supplier for making or managing decisions on asset management and maintenance. We conclude that despite the positive aspects of outsourcing, one fundamental drawback is that the firm may lose capabilities that are not only valuable in the sense of routine outsourcing, in complex maintenance outsourcing, they are evermore crucial for firm longevity. In the following section we explore firm capabilities within the framework of the resource-based view (RBV) of the firm. Building on RBV, we review dynamic capabilities and absorptive capacity, and the perspective of alliance capabilities.



## ***Firm Capabilities***

### *Resource-based view*

We chose resource based concepts as the theoretical lens because they provide a rigorous model for analyzing the firm's strengths and weaknesses (Barney, 1991; Barney, 2001). Certainly, RBV is a dominant theoretical perspective in capability research that sees resources as key to superior firm performance. Resources can be divided into resources and capabilities. In this respect, resources are tradable and non-specific to the firm, while capabilities are firm-specific and are used to engage the resources within the firm, such as implicit processes to transfer knowledge within the firm (Madhok, 2002; Hoopes, Madsen and Walker, 2003). This distinction has been widely adopted throughout the RBV literature (Barney, Wright and Ketchen, 2001). Thus, resources are stocks of available factors that are owned or controlled by the organization, and capabilities are an organization's capacity to deploy resources (Maddock, 2001). Essentially, it is the bundling of the resources that builds capabilities, (Maddock 2001).

The underpinnings of the RBV are that certain firm core capabilities must be maintained to create a sustained competitive advantage (e.g. Hanley and Ott, 2012; Jacobides and Winter, 2005; Salancik and Pfeffer, 1978; Powell and Brantley 1992). Principally, the RBV espouses that capabilities are resources that are *Valuable, Rare, Inimitable and Non-Substitutable* (VRIN). Resources are valuable if they help organizations to increase the value to the customers. This is done by increasing differentiation or/and decreasing the costs of the production. The resources that cannot meet this condition, lead to competitive disadvantage. Resources that can only be acquired by one or a few companies are considered rare. When more than a few companies have the same resource or capability, it results in competitive parity. A company that has a valuable and rare resource can achieve, at least temporarily, competitive advantage. However, the resource must also be costly to imitate or to substitute for a rival firm, if a company wants to achieve sustained competitive

advantage. The resources themselves do not confer any advantage for a company if it's not organized to capture the value from them. Only the firm that is capable of exploit the valuable, rare and inimitable resources can achieve sustained competitive advantage. In RBV, resources are given the major role in helping companies to achieve higher organizational performance.

Whilst maintenance may not be considered entirely a rare or non-substitutable process, a strong argument can be made that it may be valuable, and inimitable. In fact, it has been suggested that it may be difficult to find a resource, which satisfies all of the Barney's VRIN criteria (Priem and Butler, 2001), therefore we consider the criteria of value and inimitability to be very important.

Maintenance is not only of tactical and strategic importance (Laaksonen, Jarimo, and Kulmala, 2009; Stremersch, Wuyts and Frambach, 2001); it is extremely valuable to the firm, both to its internal and external customers. There is significant evidence from industry that corroborates this assertion. For example, leading multinational corporations (MNCs) such as DSM, Smurfit Kappa, Sara Lee, GlaxoSmithKline, Akzo Nobel and Volvo Cars consider that maintenance is a pivotal and an extremely valuable function of their firms that contributes to economic value within the overall business performance (Jonker and Haarman, 2006). Maintenance in mining may be particularly valuable because it has a degree of control on productivity. For instance, if poor maintenance causes stoppages it can be very damaging on productivity. Likewise, timely maintenance has the ability to significantly enhance productivity (Earls, 2013). In this way, maintenance has a linkage to productivity.

Maintenance may be inimitable because it involves firm capabilities that cannot be easily implemented by managers or copied by competitors. Therefore, there is a degree of credence to reason that firm maintenance may be considered valuable and inimitable; and could fit the criteria as a core capability. As such, it would make an important contribution to the firm's competitive advantage. Consequently, when a firm adopts a strategy of outsourcing of its maintenance without regard for the RBV's value and inimitability, the resulting outcome could be that the firm's

capabilities will be eroded. This observation implies that the firm must simultaneously augment, renew and adapt its capabilities (Gebauer, Paiola and Edvardsson, 2012). A firm with a steadfast collection of internal core capabilities will possess the ability to learn faster and manage its capabilities and affiliated knowledge more effectively than its rivals, thereby giving it a competitive advantage (Wright, Dunford and Snell, 2001).

### *Dynamic capabilities*

Building on recent RBV research (Ambrosini and Bowman, 2009; Wang and Ahmed, 2007), capabilities can also be understood to be static (operational) or dynamic (involving adaption and change). Dynamic capabilities have been defined as the capacity of the organization to purposefully create, extend, or modify its resource and capability bases to address changes in its environment (Eriksson, 2014). Whilst service maintenance includes operational and dynamic capabilities, it is the dynamic capabilities that are of relevance in this study. They enable the firm to change, adapt, integrate and reconfigure resources and operational capabilities (Cepeda and Vera, 2007; Saeedi, Dadfar and Brege, 2014; Zahra, Sapienza and Davidsson 2006).

Dynamic capabilities have been further portrayed as being innovative, adaptive or absorptive. Wang and Ahmed (2007) suggested absorptive capacity as the main dynamic capabilities. We agree with this viewpoint in reference to maintenance outsourcing and consider that absorptive capacity is important in managing knowledge that is pertinent to outsourcing maintenance. In terms of outcomes there is agreement that dynamic capabilities are linked to the competitive advantage of the firm, or to its performance (Eriksson, 2014), although there is some debate about the exact mechanisms of this linkage (Ambrosini and Bowman, 2009)

### *Absorptive capacity*

Absorptive capacity is another source of competitive advantage and plays a central role in a firm's ability to develop capabilities through innovation and fostering knowledge creation ability (Cohen and Levinthal, 1990). Absorptive capacity is relevant to outsourcing maintenance in that it

completes the sequence and links capabilities back to the firm's strategic capabilities. According to Cepeda, Navarro, and Jimenez (2012), a firm's absorptive capacity involves engaging in new practices and employees having to adapt to new practices that are likely to differ from the existing, familiar ones. For example, when the firm outsources its maintenance, it will require exceptional capabilities to deal with the suppliers. These capabilities have been termed 'alliance capabilities' (Wang and Rajagopalan, 2015).

### *Alliance capabilities*

An Alliance capability is a source of competitive advantage and encompasses a variety of functions, such as the ability to select the right supplier and the ability to build trust-based relationships (Ireland, Hitt, and Vaidyanath, 2002). Research on this topic not only provides a concrete way to conceptualize and understand firm capabilities but also starts to unravel the learning processes that lead to capabilities (Kale and Singh, 2007). From a practical standpoint, this stream of research tries to explain why some firms are able to realize better performance than others from alliances such as outsourcing (Ireland, Hitt, and Vaidyanath, 2002).

Alliance capabilities help explain the causal mechanism that occurs between the firm and the supplier (Wang and Rajagopalan, 2015) and describes this mechanism as incorporating "value creation" or "value capture." For instance, repeated interactions with the same supplier may lead to greater joint value-creation ability (due to increased ability to coordinate) and the effect on alliance between the firm and the supplier may be positive. On the other hand, if recurrent experiences with the same supplier boost that supplier's ability to capture private value (perhaps as a result of a deeper understanding of how to exploit the collaboration for private gains), then the alliance may suffer because the supplier derives asymmetric benefits and siphons them away from the firm (Kumar, 2010). Additionally, alliance capabilities have been described as being important at two levels: (1) individual-alliance capabilities that focus on a firm's abilities to initiate, manage, and terminate the contract with the supplier (Schreiner, Kale, and Corsten, 2009), and (2) dyad-specific alliance

capabilities that reflect the relational capability of a dyad (Dyer and Singh, 1998; Wang and Zajac, 2007). Overall, capability arguments imply that whether technology outsourcing ‘hurts or benefits’ a firm’s capabilities will depend on whether the firm can integrate externally sourced technology with internal processes (Weigelt, 2009).

In sum, this review of the extant literature suggests that the mining firms need capabilities that are relevant for their current and future strategy. The extant literature recognizes that outsourcing maintenance runs the risk of losing certain firm capabilities. In addition, dynamic capabilities and absorptive capacity may play a central role in knowledge creation needed for the development of firm capabilities. Finally, the strategic alliance capability concept implies that the skillful management of the relationship with the supplier is essential. Thus, it is reasonable to assume that when the mining firm outsources its maintenance without considering the *ex post* consequences of the loss of certain capabilities, the ensuing consequence could be the annihilation of its sustainable competitive advantage.

## **Method**

The present scholarship is a multiple case study of an exploratory nature, with the ambition of identifying how different ‘make or buy’ and supplier selection patterns (strategies) impact on the firm’s strategic capabilities. In order to obtain a more thorough understanding of the phenomenon, we conducted a dyadic study. While we included both buying and supplying firms, our focus was the perspective of the mining companies. The emphasis of our study was the four buying firms—focal case studies—plus supplementary data from the six suppliers of mining equipment and maintenance services that participated in the research.

We selected case studies because we wanted to conduct a ‘total’ study of all key actors in the system (Håkansson and Snehota, 1995; Normann, 1970), including the smaller mining companies and suppliers. The four case studies of mining firms represent Swedish actors. We chose Sweden because mining in Sweden is performed with world leading technique, high standards and world-

class productivity. Mining in Sweden is also a significant and sizeable industry. For example, 10,000 people are directly employed in the mining industry and a further 35,000 are indirectly employed (Dyer and Pehrson, 2014). Sweden is one of the EU's leading producers of ores and metals and contributed SEK 26 B to Sweden's GDP in 2010 (Dyer and Pehrson, 2014). Additionally, there has been strong collaboration and co-development between large mining companies and market-leading suppliers of mining equipment and service (Biggemann, Kowalkowski, Maley and Brege, 2013).

Data were gathered through 15 face-to-face interviews with executives, managers, and specialists of four mining and six supplier companies (see table 2). The length of the interviews varied between 30 and 95 minutes. Respondents were identified using a snowball-sampling procedure (Goodman, 1961; Johanson, 2000). Whenever possible, multiple sources were used to “discover new dimensions of the research problem” (Dubois and Gadde, 2002). We gathered data until we perceived repetition of information and confirmation of firms' rationale for maintenance decisions, and the influence of outsourcing on the firms' capability development (theoretical saturation; Eisenhardt, 1989). Complementary data were also collected as a desk study. This data included other information deemed relevant and mainly comprised the annual reports of the firms. These reports included data on operations, general corporate information, accounting policies, balance sheet, cash flow statements, profit and loss information, human resource and sustainable emphases and occupational health and safety strategies. In this manuscript we consider that maintenance includes three types of key activities: (1) service operations on installed facilities and equipment, (2) the handling of wear and spare parts, and (3) specialized consultancy and service work. In this study, our particular area of interest is (1) service operations. We chose to center on service operations because mining companies always buy spare parts and the supplier has always delivered maintenance connected to special equipment. Essentially, we explore service operations and some extra special services such as special studies on production efficiency and calibration of equipment.

One of the authors has 20+ years of experience of working in the mining sector, which means that we had extensive pre-understanding of the empirical phenomena when conducting the study. Two researchers participated in every interview, which enabled us to take detailed notes, as for example in the cases where respondents were reluctant to allow the interview to be recorded due to the sensitive nature of the topics discussed. The data was based on the write-ups about each case company. We summarized the data by pulling together themes and identifying patterns related to the characteristics of the maintenance offerings (including how they are purchased and supplied), capabilities required, supplier-buyer relationships, and attitudes towards outsourcing. After completing each within-case analysis, we initiated a cross-case analysis, looking for similarities and divergences across cases to find common patterns regarding outsourcing and capability development.

\*\*\*\*\*Insert about here: Table 1\*\*\*\*\*

## Interview Summary

### *The case companies*

The four case studies of mining firms represent a majority (close to a total study) of actors in the Swedish mining sector. From a supplier perspective, three out of four major Swedish and Finnish suppliers are included, together with two smaller suppliers. Taken together, our sample covers a large proportion of the Nordic mining industry. The four firms divide easily into two categories: the first category is the two large and established mine corporations: Firm C and Firm D. Moreover, Firm C is Europe's the largest iron ore business and wholly owned by the Swedish state. While, Firm D is a large Swedish MNC that is running several mines and smelters in Sweden, Ireland, Finland and Norway. The second category is the two smaller firms A and B. Firm A is a small start-up mining company. It is reopening an iron ore mine in the middle of Sweden, which has been closed down for some twenty years. Mining production started in 2012 according to plan. Due to recession in the mining industry, business has been slow and finances are under immense pressure. Firm B, a small Swedish mining company operating since 1857, producing zinc, lead, silver and copper.

\*\*\*\*\*Insert about here: Table 2\*\*\*\*\*

### The Characteristics of the Mining Firms

The six suppliers also divide effortlessly into three categories: (1) International suppliers of mobile equipment, Atlas Copco and Sandvik. Atlas Copco is a world-leading supplier of different kinds of mobile equipment, including drill rigs and different kinds of trucks. The other Swedish supplier, Sandvik, Atlas Copco's closest competitor, will be studied through the lenses of their customers. (2) International suppliers of installations and fixed equipment: ABB, Metso Mining and Construction, and Outotec. ABB is a world-leading supplier of electrical power infrastructure, infrastructure, electrical engines and mine hoists. Metso and Outotec are process equipment manufactures and—especially Outotec—focus on engineering services (a buy-out from Firm D. (3) National and local suppliers of service, Monitoring Control Center (MCC) and BEFAB. MCC is a consultant in maintenance development and condition monitoring. BEFAB is a local provider of underground transportation services.

### **Analytical results**

#### *Individual analysis of the four case companies*

##### *Firm A*

At Firm A, the ratio of outsourcing/in-house is 50/50. The firm engages with three suppliers, outsourcing/ in-house is deemed cost neutral and the firm does not favor one method superior to the other. They do however, worry about dependence on the supplier and in order to reduce this dependence they stay close to the outsourcing firm and learn the fundamentals of how to maintain new systems and to do basic maintenance.

##### *Firm B*

At Firm B, the ratio of outsourcing/in-house is 40/60. The firm engages with a single supplier, Atlas Copco, outsourcing/ in-house are deemed more or less equivalent. Though, the firm does find that outsourcing offers attractive solution contracts, they, nonetheless, also worry about locked-in effect



and are concerned with becoming too dependent on the supplier. According to the mine manager at firm B, there are other questions being asked: *“Which resources do we have?” “Are we buying a single machine or a fleet?”* and *“Can we accept becoming dependent upon the supplier?”* The decision to outsource is not stated to be a cost-issue but the balance between outsourcing and in-house swings back and forth over time. Currently, the mine manager feels it they are leaning towards in-house, to avoid the lock-in effects of suppliers.

#### *Firm C*

At firm C, the ratio of outsourcing to in-house is 80/20. The firm has several major suppliers; Outsourcing viewed positively and offers capacity regulation in phases of business cycle and flexibility. Instead of hiring 15 maintenance workers for running a new drill rig during all shifts, outsourcing is a less multifaceted solution. On the other hand, outsourcing seen as the more expensive option. The pendulum between outsourcing and in-house is always swinging-for the moment, towards in-house

#### *Firm D*

At Firm D, the ratio of outsourcing/in-house is also 80/20. This firm uses several major suppliers and outsourcing is deemed as positive and they have strong long-term relationships with their suppliers. The purchasing manager states: *“Our entire thinking on service issues is based on availability.”* Firm D also sees other advantages from sourcing. One is that an external partner could be better at solving “small problems”, problems that are overlooked in a large organization such as firm D. Contrariwise, they are fearful of becoming too dependent on suppliers and the balance between sourcing and in-house is always a dilemma. Overall, the strategy is a mixed one and based on what is best for availability. The results of the four firms are illustrated in Table 3.

\*\*\*\*\*Insert about here: Table 3. \*\*\*\*\*

#### The Analysis of the Mining Firms

These individual company results will now be analyzed from a collective viewpoint. Two key factors emerged in the analysis to be vitally important for all firms. These were classified as 1) the rationale and 2) the impact on firm capabilities. These will now be considered.

### *1) The rationale for outsourcing of maintenance*

All four case study firms reported that they were in support of outsourcing maintenance. However, the degree of the firms' outsourcing appears to be related to their size (see table 3), cost factors and economies of scale.

#### *Cost factors*

Although cost is claimed to be an important factor in the decision to outsource in the extant literature (Fill and Visser, 2000; Kremic, Tukel and Rom 2006), contrary to expectations, cost it did not emerge to be the most important factor in the initial decision to outsource maintenance.

#### *Economies of scale*

Similarly, economies of scale materialized as a significant item for the firms. The start-up firm testified that they felt obliged to avoid building up an internal maintenance structure; they only ever obtained economies through standardized products. Moreover, the small specialist suppliers appeared to offer greater responsiveness and access to new technologies that the start-up firm in particular lacked. Kakabadse and Kakabadse (2000) argue that a solution to a firm's economies-of-scale predicament is to build a network of suppliers. Such a network would moderate the firm's need for vertical integration while allowing it to achieve economies of scale.

### *2) The impact on firm capabilities*

The impact of outsourcing on firm capabilities emerges to be dependent on size, specialization, human resources structure, the external environment, the relationships with the suppliers and the impact of prior experiences in maintenance. The larger firms reported that some skills and competencies were decisively kept in-house, the smaller firms did not consider this action.

### *The pace of specialization*

The pace of specialization arose frequently during the interviews with informants. Informants said that maintenance necessitated different types of infrastructure for above and below ground; and that such infrastructure means allocating significant resources and expenses of having to support equipment in-house. Letting suppliers set up their own specialized workshops was considered by most of the informants as an enhanced and more cost effective alternative. This was not seen as risky and no one mentioned that when this occurs the firms will lose the tacit knowledge required for these specialized capabilities

### *Human resource structure*

Human resources and its structure featured prominently in the interviews. For instance, one of the key arguments raised by the informants in favor of outsourcing was the firm's potential to reduce costs by outsourcing and decreasing the functional human resource structural complexity. The informants claimed that rationalizing their human resource structure would allow the remaining employees to focus on the more centralized area of the business. However, the informants were vague about this and were unable to specify exactly what these new competences would entail. In some interviews it was clear that the informants did not consider the capabilities of the employees who carried out the maintenance to be a factor in this decision. According to Weigelt (2009), the decreasing manpower will have a huge impact on the firms' capabilities, in particular their ability to attain and retain knowledge. It surfaced that although maintenance was viewed as vital and stoppages as catastrophic, the capabilities required to do the maintenance were somehow perceived as assignable and not viewed as important to retain in-house. Service maintenance was not seen as tacit knowledge that is either a strategic consideration or a dynamic capability.

### *The external environment*

The external economic environment was raised numerous times by the informants. It emerged to be an important factor in regards to not only the decision to outsource but also on the continuation

and development of specific firm capabilities in relation to outsourcing. For example, the degree of economic uncertainty will influence both the push to outsource and the degree of maintenance of in-house capabilities (Kremic, Tukel and Rom, 2006). The degree of uncertainty can manifest itself in several ways. For instance, greater uncertainty may also make it more difficult to define the requirements and expectations of outsourcing performance (Kremic, *et al.* 2006). In addition, the decision to outsource capabilities may be a random affair, rather than a strategic consideration of the firm's future requirements.

The characterization of uncertainty on capability development in the mining business is therefore a consequence of a multitude of environmental and contextual factors. (Duncan, 1972: 318). Consequently, there is reason to expect that such uncertainty may systematically influence the decisions that mining firms make and usually involve the reduction in variable costs such as in outsourcing their maintenance which in turn influence the development of the firm's bank of capabilities (Bhattacharya, Gibson and Doty, 2005). These cost-cutting decisions are important and can have a short-term positive affect on the bottom line, but they can also have negative repercussions if the decisions are made hastily and not part of a longer-term strategic plan (Carpenter and Frederickson, 2002).

Correspondingly, during uncertainty, when ambiguity, complexity and information overload increase, development and continuance of firm capabilities will typically be abandoned (Kochanski and Sorensen, 2005; Maley and Kramar, 2014). Uncertainty was particularly important for Firm A's decisions to outsource to expert suppliers that were not only competent but also provided stability on costs and efficiencies.

The firm's capability development emerged to have some relevance to the larger firm's informants but not so for the smaller firms. It became evident during the interview with the informants of the larger firms that the decision to outsource was at least partly viewed as a longer-term planning process by top management and this strategy sometimes included some on-going

development of capabilities. However, in the smaller firms there was little evidence of long-term strategic planning. All four firms reported that maintenance was extremely important because if the quality of maintenance deteriorated, the chances of fatal production failures would increase. Such obstacles would increase costs and also negatively impinge on the firm's productivity and reputation. Interestingly, only the two large firms associated the importance of maintenance with maintaining some in-house capabilities. Evidence from the study suggests that when tacit knowledge is totally relinquished to the supplier, the regeneration and creation of tacit knowledge of new capabilities could be challenging.

#### *The relationships with the suppliers*

It also became apparent that the larger firms also had superior bargaining capabilities for managing relationships with the supplier (Zaheer, Gulati, and Nohria, 2000). Their increased bargaining power with the suppliers emerged to provide them with considerably superior results. However, it became evident in the interviews that the capabilities of the start-ups did not extend to bargaining skills. According to Holcomb and Hitt (2007) and Salla *et al.*, (2013), this may significantly reduce the bargaining power of smaller and start-up firms. The knowledge required for bargaining capabilities could only be defined as generally implicit knowledge, yet the smaller firms appeared to lack this basic implicit knowledge that allowed them to gain superior bargaining capabilities. Thus, the findings support Weigelt (2009) and suggest that outsourcing may have a less detrimental impact on firms' integrative capabilities when the firm has experience in prior related maintenance. Likewise, they agree with (Bahli, and Rivard, 2003) that experience with suppliers is important.

#### *Impact of prior experiences in maintenance*

The meager attempt to retain some capabilities in-house could be occurring because senior managers seemingly understood their importance; or they could be simply appeasing the strong union backup in the Swedish mines. The positive role of prior maintenance experience is supported by several

scholars (i.e. Cohen and Levinthal, 1990; Helfat and Peteraf, 2003; Weigelt, 2009). For example, the prior experience of the large mine companies could be a factor that made them disinclined to hand over all maintenance responsibilities to suppliers in turnkey projects and large life-cycle service contracts. It transpires that larger mining companies try to a degree to avoid lock-in and being too dependent upon specific suppliers. One solution to this problem was to keep a small portion of operations in-house and another was to source from multiple suppliers. Although, there was an awareness of the risks of lock-in effects from equipment suppliers, there was no serious criticism towards these suppliers for misusing their single source positions. It is what Williamson (1985) refers to as opportunistic behavior.

The small mining companies, especially the start-up, were even more reliant upon suppliers and susceptible to lock-in. They were usually involved with fewer suppliers and defined broader scopes for the maintenance assignments. Firm A was involved in the development and construction of a processing plant, but selected ABB as supplier of maintenance for the entire plant. Also, Firm A, the small mining company, keeps down the in-house maintenance operations, especially maintenance that demands high competence. It is sourced from the equipment suppliers, as in the case of the powertrain of the scoop tram where Caterpillar performs maintenance.

The cycle of lock-in effect in the firms is exemplified in Figure 1. This figure illustrates the probability of locked in effect as a result of outsourcing maintenance. For example, (step 1), the decision to outsourcing occurs, (step 2), in line with RBV, the firms capabilities are weakened. Subsequently, the weakened capabilities impact the firm's dynamic capabilities (step 3) and absorptive capability (step 4). In turn, there will be a loss of the firm's ability to renew or create tacit knowledge (step 5). The outcome is that the firm has to continue the cycle of maintenance. In other words, the firm is restricted in its future strategic options and there is an increase in the risk of locked-in syndrome.

.....Insert about here: Figure 1:

## **Discussion**

The four cases show that the large firms outsource by 80 percent, the middle-sized firm by about 90 percent and the start-up firms outsource almost 100 percent of their service maintenance. These findings are not groundbreaking in themselves; mining companies have outsourced maintenance for many years. The empirical data doesn't say that outsourcing is increasing, rather that it remains at a high level. What has changed remarkably is the degree of strategic importance of maintenance to the firm.

Maintenance has become more strategic because the costs of production stops have grown exponentially. The scholarly literature and our empirical data indicate that production stoppages can be more complex to resolve and can be catastrophic for the mining firm's P & L, especially at a time of high demand. Outsourced maintenance is thus seen by the firms as a major driver to improve production efficiency and hold down the need for future capital investments.

As the firms continue to outsource, they inevitably lose certain maintenance related capabilities. Or, in the case of the smaller firms, they will never create the maintenance capabilities. This would indicate that the firms are subject to lock-in effect and outsourcing maintenance is inevitably irreversible.

There are clearly some intriguing repercussions from a firm capability point of view. Foremost is the increasing capability gap between the mining firm and its suppliers. There are two reasons for the emergence of this capability gap. The first reason is the loss of capabilities to the supplier. The second reason is the lack of new capability development.

The loss of capabilities is heightened due to the failure of the firm to be involved in the outsourced maintenance process, once it relinquishes it to the supplier. Although outsourcing can provide firms with access to expert maintenance know-how, they still need to maintain a level of awareness in the process. The building of capabilities related to these technologies requires learning

by doing and investment in internal processes (Ethiraj, *et al.*, 2005; Weigelt, 2009). Maintenance processes are unique and firms learn in situ about a new knowledge while using it (Attewell, 1992). Such learning, however, will routinely decline as a “hands-off” outsourcing approach continues. Hence, to form or, at least, preserve a base-line level of maintenance capabilities, firms need to have a level of involvement in the process.

This level of involvement suggest that all the firms still needs to understand how the outsourced maintenance capabilities relate to its internal processes (Weigelt, 2009). In other words, the firm needs to manage the transferal of explicit and tacit knowledge from the supplier when they outsource. They need to keep closer surveillance on their outsourced maintenance and they should have some involvement in managing employee relations with the supplier (Gebauer *et al.*, 2014; Quinn, 2000).

It became clear in the study that in order to better manage the relationship with the supplier, the firms require excellent strategic alliance capabilities. Whilst the larger firms showed some evidence of certain alliance capabilities, there was probably scope for improvement. On the other hand, the smaller firms appeared to be particularly deficient in these capabilities and mentioned that they felt very exposed to some suppliers. Evidence emerged that suggested that all the mining firms needed superior ‘alliance capabilities’ in order to manage the relationship with the supplier. Additionally, the alliance capabilities were needed at both the individual level to help focus on the firm’s abilities to initiate, manage, and terminate the contract with the supplier (Schreiner, Kale, and Corsten, 2009), and at a dyad-specific level to better reflect the relational capability of the dyad (Dyer and Singh, 1998; Wang and Zajac, 2007). Although alliance capabilities would be unlikely to prevent lock-in effect, they could enable improved negotiation skills and help propagate a constructive binding contract that may ease the pressure of lock-in effect and reduce firm liability.

Consequently, when a firm decides to outsource its maintenance in complex processing industries such as mining, it needs to have alliance capabilities that override the altered core competencies and lock-in effect (see figure 2). Simply put, the firm needs to firmly establish a link



that enables them to maintain control of maintenance. This is perhaps best managed in respect to the loop back to productivity. By this we mean that the firm needs to develop new alliance capabilities within the domain of lock-in effect that enables it to maintain the important mechanical loop to productivity.

Likewise, trends in mining that are driving forces towards increasing productivity and safety such as predictive maintenance, health management and automation are good examples of the need for the firm to acquire very efficient alliance capabilities. Superior alliance capabilities will contribute to extending a degree of power back to the firm's maintenance department, something that used to be restricted to supplier (Earls, 2013).

RBV theories imply that the firm's capabilities depend on whether a firm can successfully adapt outsourced maintenance with internal processes (Weigelt, 2009). Dynamic capabilities imply that the firm should be flexible and be able to reconfigure their resources to nurture capabilities during outsourcing. This reconfiguration supports the development of absorptive capacity that encourages external understanding and includes the development of alliance capabilities.

The larger and more experienced firms did materialize to have a degree of 'alliance capabilities.' Conversely, this was not evident with the smaller firms. The concern for these firms is that they do not have the capabilities to support any maintenance in-house, nor do they appear to have alliance capabilities. This not only puts them in a very weak position with the suppliers, it raises important questions in regards to their strategic intent. Our concern agrees with Weigelt (2009), who reasons that a shortfall of capabilities may impact more adversely on the strategy of the smaller firms. As such, when a firm decides to outsource its maintenance, there is an increasing need for strategies that help firms to build 'new capabilities' such as managing the relationship between alliances and managing employee relations within alliances. In line with (Rothaermel, Hitt and Jobe, 2006), we encourage the firms to practice a balanced approach when outsourcing their service maintenance activities. Figure 2 illustrates that when maintenance is outsourced to the supplier, the firm loses its

direct relationship with productivity, its maintenance capability link. However if alliance capabilities are fostered with the supplier, the firm can retain the link with productivity. This in turn reduces the impact of lock-in effect.

\*\*\*\*\* insert Figure 2 here\*\*\*\*\*

### The Changed Core Capabilities in Lock-in Effect

#### *Limitations and future direction*

This study is not without limitations. The study was conducted in a single country, Sweden; a global study involving a greater number of countries would be ideal. The study was also confined to managers of the firm and its range of suppliers. An additional consideration is that outsourcing maintenance could be very different from industry to industry. Whilst, we have focused on complex processing operations of mining and consider our results give a fair portrayal of outsourcing maintenance across mining in developed countries, the results of a similar study may have some differences in other industries.

In regards to future studies, it could be argued that there are many directions to which the outsourcing research can be taken in the near future. Firstly, the management of versatile outsourcing relationship portfolios appears to be one of the future managerial challenges. Secondly, a new research focus could be the correct timing of outsourcing decisions. Thirdly, small and medium sized enterprises (SMEs) provide an important area for further studies on outsourcing. Fourthly, future studies could incorporate a greater number of stakeholders such as human resources managers and union representatives. Forthcoming research should also examine in greater detail precisely how capabilities could be continuously developed whilst outsourcing. If we conceptualize dynamic capabilities, absorptive capacity and alliance capabilities as higher-order capabilities (Wang and Rajagopalan, 2015) that need to be constantly audited, then, by definition, we need to clearly distinguish them from lower-order capabilities, conceptually as well as empirically (Wang and

Rajagopalan, 2015). Research that investigates these differences, particularly in process industries such as in mining, could be very useful. Research should also address how high technology outsourcing firms from different industries develop business models to maintain their competitive advantage.

## **Conclusion**

To conclude, all the Swedish mining firms in this study emerge to have little choice but to outsource their maintenance. The pressure to reduce costs and the difficulty in the attraction and retention of expert talent appear to be the chief contributing factors that limit the mining companies' choices and result in their decision to outsource a large percentage of their maintenance. A major problem with the decision to outsource is that the firms inevitably risk lock-in with the suppliers. Subsequently, the risk of lock-in effect is the loss of capabilities that are important to the firm.

While evidence suggests that maintenance may be considered a core capability, what appears to be more important is the direct link that maintenance has to productivity. In this way, maintenance may be described as a type of 'transient core capability.' In other words, the critical role of maintenance is the loop back to productivity. However, when firms outsource maintenance to a supplier this loop may be weakened or absent. This situation could exacerbate the negative repercussions of lock-in effect for the firm. In order to avoid this detrimental situation, the firm needs to extend and modify capabilities that facilitate the link between maintenance and productivity. These capabilities have been identified as 'alliance capabilities.'

If firms do not develop alliance capabilities with the supplier, the ultimate outcome will be that these firms will be not only locked-in with their current suppliers; they will be constrained in their future strategic options. Whilst, the mining companies were aware of the risk of lock-in effect in regards to the supplier hiking prices in negotiations, they were less aware of the risk to their capabilities and the ensuing limitations this invited

The indisputable global competition, characterized by rapidly evolving technology has put

forward a lot of challenges for management (Waeyenbergh and Pintelon, 2002) and, as such, constantly demands new battle plans. One of the important challenges in outsourcing complex process maintenance is understanding the full impact that outsourcing maintenance has on firm capabilities and ultimately the firm's future strategy and sustainable competitive advantage. A first step in unraveling this quandary could entail an enhanced understanding of the key high-order capabilities that need to be nurtured and those that need to be created in long-term extensive outsourcing where lock-in effect is anticipated.

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**Table 1. Interview summary.**

<b>Mining Company</b>	<b>Firm characteristics</b>	<b>Position of informants</b>
Firm A	Small developing mining company	1. CEO of mining division
Firm B	Small mine	2. Mine manager, 3. Purchasing manager
Firm C	Large mining company	4. Strategic purchaser 5. Technical manager
Firm D	Diversified large mining company	6. CEO, Procurement manager
<b>Supplier</b>	<b>Firm characteristics</b>	<b>Position of informants</b>
ABB	Diversified equipment manufacturer (e.g., mine hoists)	7. Vice President, 8. Head of Mining
Atlas Copco	Mobile equipment manufacturer (e.g., rock drill rigs, underground trucks)	9. Application specialist, 10. Application specialist
BEFAB	Service provider (e.g., underground hauling)	11. General manager
MCC	Advanced maintenance service provider (e.g., monitoring systems)	12. CEO
Metso	Processing equipment manufacturer (e.g., mill equipment, bulk material handling)	13. Commercial manager 14. General manager
Outotec	Processing equipment manufacturer (e.g., mill equipment, bulk material handling)	15. Sales manager

**Table 2. The characteristics of the mining firms**

<b>Firm</b>	<b>Size</b>	<b>Characteristics</b>
Firm A	Small	Iron ore mine– Swedish start-up mine in the middle of Sweden. Mining production started in 2012. Due to recession- business has been slow and finances are under pressure
Firm B	Small	Zinc mine-Swedish firm operating since 1857, producing zinc, lead, silver and copper.
Firm C	Large	Iron-ore- Europe's the largest ore mine owned by the Swedish state.
Firm D	Large	Iron-ore- Swedish MNC running several mines and smelters in Sweden, Ireland, Finland and Norway

**Table 3. The analysis of the mining firms**

<b>Mine Firm</b>	<b>In-house Vs. Outsource</b>	<b>Suppliers</b>	<b>Positive perception of outsourcing</b>	<b>Negative perception of outsourcing</b>	<b>Other remarks</b>
Firm A	50/50 Outsourcing /in-house	Three suppliers	Outsourcing/ in-house neutrally	Cost neutral Lock-in	Engages with outsourcing firm Learn how to do basic maintenance
Firm B	40/60 Outsourcing /in-house	Single supplier, Atlas Copco.	Outsourcing/ in-house neutrally -Solution contracts attractive.	Lock-in	Decision to outsource not cost-issue. Concerned with dependence on supplier.
Firm C	80-/20- Outsourcing /in-house.	Several major suppliers	Outsourcing positive Capacity regulator Flexibility	Outsourcing expensive option	The pendulum between outsourcing and in-house is always swinging
Firm D	80-/20- Outsourcing /in-house	Several major suppliers	Outsourcing positive Strong relationships with suppliers Availability Outsourcer improves problem solving	Becoming too dependent on suppliers	The balance between sourcing and in-house is always a dilemma.

**Figure 1: The cycle of outsourcing maintenance**



**Figure 2: The changed core capabilities and lock-in effect**

